Fighting fit

Major developments in prosthetics and rehab allow more seriously injured soldiers to return to at least some of their previous life

By Heath Reidy

One step at a time: Overcoming the trauma of a lost limb demands patience and perseverance

Even after battlefield injury or trauma, most British soldiers return to the frontline to fight another day. Because of the crucial process of rehabilitation, the MoD says that 95% of soldiers who have come home for treatment return to their duties once fit enough.

The number, however, is falling. Despite better protective gear for troops, the conflict in Afghanistan has seen an increase in the number of more severe life-changing traumatic injuries, specifically blast injuries and the loss of lower limbs. According to the NHS's defence medical services early last year, the number of soldiers returning to the frontline has fallen 10%.

The Defence Medical Rehabilitation Centre (DMRC) at Headley Court in Surrey is the principal institution for medical rehabilitation of injured military personnel in the UK. The DMRC, which has taken in many injured British soldiers from Afghanistan, admitted 103 patients in 2008. Half of them were the victim of blast injuries and 40 were amputees.

With traumatic injuries on the increase, there is no better time for engineers to develop technology that improves the rehabilitation process. Rhodri Phillip, consultant in rheumatology and rehabilitation at Headley Court, says: "Engineers have always been crucial because they are the ones that have been designing the prosthetic limbs and the components," he says. The last decade has seen new materials and manufacturing processes that have opened the doors for cleverer designs and more technically advanced products.

Engineering consultant Frazer-Nash is one UK company that is supporting solider rehab by putting its own mark on a traditional form of gym equipment – the exercise bike.

The company has been working with Headley Court to develop the bike and adapt it to treat injured soldiers. Rehabilitation for patients with serious leg injuries is often restricted because they have to wear external fixators – metal cages fitted around the leg to set complex bone fractures. But Frazer-Nash's bike is designed so that the injured soldier can use the equipment without the fixator getting in the way.

Alex Knight, Frazer-Nash engineering consultant, says the bike is a piece of gym equipment Headley Court has been in serious need of because of the rising number of blast injuries.

"They are getting more of these guys coming through with fixators who just can't use the current kit," she says. "They all stressed that the bike is something that is desperately needed."

Knight compares the design to that of a pedalo. The pedals face inward towards each other rather than outwards and there

is no central structure impeding leg movements. The distance between the pedals, which are connected via a pulley system and an external drive shaft behind the bike, can be adjusted for those soldiers who are wearing fixators on both legs. The seat is supported from the back of the machine, allowing the patient to mount and dismount without having to manoeuvre their leg over it as with the traditional design.

The pedals also have adjustable crank lengths so the soldier can pedal in small or large circles, depending on the severity of the injury and their progress through the rehabilitation process.

Frazer-Nash is also developing a wheelchair wheel that monitors progress in amputees. A series of sensors in the wheel measure the level of force generated by the patient when using the wheelchair. The information is transmitted to a wireless mini-computer, allowing the soldier and doctors to measure progress.

It is a motivator, says Knight. "At the moment they have no quantitative feedback," she says. "This will provide them with numbers – power per push and pushes per minute – so they will be able to get that feedback in real time."

Use of both the exercise bike and the wheelchair wheel could be broadened to include non-combatants. The bike, for instance, has potential for stroke victims. Frazer-Nash is in talks with other medical rehabilitation providers about how the equipment can be adapted.

Knight says: "If we can show potential benefit then hopefully we will be able to do more trials to show the benefit of how it will help a wider population."

Another company supporting amputee rehab is Blatchford of Hampshire. It is developing prostheses that allow soldiers who have lost their lower limbs to return to the frontline to carry out duties much as they did before the injury.

Ben Blease, a clinical prosthetist at Blatchford, says getting the design of lower limb prostheses absolutely right is crucial. Lower limb prostheses put a heavy demand on the body and that can lead to further injuries such as hip and back problems. According to the MoD, walking with a false leg uses 125% more energy than walking on uninjured legs.

The company's latest design takes more account of the strain on the body and makes limb use easier for the amputee back on duty, whether they are running up and down rough terrain or jumping out of a helicopter.

"The point of developing this technology is to make sure that when the soldiers are walking or moving around we are not actually creating further damage up their body," says Blease. "Soldiers in the field of operations need robust knees and feet that allow them good energy responses."

One of Blatchford's products under development is an electronic knee prosthesis. Described as a more sophisticated version of its Smart Adaptive prosthetic knee, it uses sensor data to operate a combined hydraulic and pneumatic knee flexion control device. Sensors inside it can detect whether the soldier is walking or running on any surface from steps to flat or uneven ground. The prosthesis responds by increasing support of the upper body of the soldier on the move.

If the soldier has to suddenly run faster or slow down, the sensors work out the speed and increases or reduces knee movements. The prosthesis is strong enough to withstand 150kg in bodyweight and heavy kit.

Better kit (clockwise from above): **Blatchford's Smart Adaptive knee and KX06; the Frazer-Nash bike; Alex Knight with the monitoring wheel; the EliteVT promises an active life – even skiing**

Blatchford's latest foot prosthesis, the EliteVT, is also aimed at returning amputee soldiers to the frontline. It consists of a sophisticated machined coil spring that allows the top part of the prosthesis, connected to the soldier's leg, to compress and twist fluidly. With this flexibility the soldier can run, jump and turn more easily without skin damage – another common injury cause by prostheses.

Blease says the spring, which has not been used in prostheses before, was originally made of stainless steel. Titanium is instead to make the prosthesis lighter.

Technical improvements throughout the rehabilitation process are helping more injured soldiers recover and confidently go back to the frontline fit, healthy and in the best possible physical condition.

As companies come up with even sharper product designs, will the technology one day be relied on as the single best solution for rehabilitating the troops?

Phillip says it won't. "There is always going to be a role for it to assist in rehabilitation," he says.

"We are making use of newer technologies probably at earlier stages than we would have done in the past and that's certainly proving a benefit. But at the end of the day the key people are always going to remain the medical staff and the therapists who actually drive things forward." ?